

## **REMARKS**

This is a full and timely response to the Final Office Action mailed July 10, 2008, submitted herein with a request for allowance of the application and all presently pending claims.

Upon entry of this Response, claims 1-12 and 14-40 are pending in this application. Claims 1 and 14-39 have been withdrawn by the Examiner. Claim 40 is herein canceled. Claims 3, 10, and 12 are herein amended. The prior art made of record has been considered but is not believed to affect the patentability of the presently pending claims. Applicants believe that no new matter has been added and that a new search is not required to examine the amended claims.

### **Claim Objections**

Objection of claim 12 was maintained.

Applicants refer to the supplemental amendment to the present application filed April 3, 2008, and acknowledged by the Examiner, where claim 12 has been amended to refer the limitations within claim 12 to the "flexible proton electrolyte membrane" of claim 2. Applicants assert, therefore, that the objection of claim 12 with regard to lack of antecedent basis is answered. Applicants also note that there is full support for the subject matter of claim 12 in the specification in the paragraph beginning at line 12, page 15.

Examiner noted an informality in claim 40.

Claim 40 is herein canceled, and therefore the objection with respect to claim 40 is now rendered moot.

### **Rejection under 35 U.S.C. §112, second paragraph**

In the Final Office Action mailed July 10, 2008, Claims 10-12 were rejected under 35 U.S.C. §112, second paragraph for allegedly failing to particularly point out and distinctly claim the subject matter which the Applicants regard as the invention. In particular, claims 10-11 were asserted by the Examiner to recite the limitations " $-R^2A-$  and " $-R^3$ " with insufficient antecedent bases for the limitations in the claims. Claim 12 was asserted by the Examiner to recite the limitations " $-R^2A-$  and " $-R^3$ " with insufficient antecedent bases for the limitations in the claim.

Applicants respectfully traverse the rejection. However, purely for reasons of clarity, Claims 3, 10 and 12, and hence claim 11 dependent on claim 10, are herein amended to more clearly state that each of W, X, Y, and Z is selected from the group of  $-R^2A$ ,  $-R^3$ ,  $-O-$ , and  $-OPO_3H_2$ , wherein each of  $R^2$ ,  $R^3$ , and  $R^4$  is a hydrocarbon, and that in claim 12 Q is selected

from  $-OPO_3H_2$ ,  $-R^2A$ ,  $-R^3$ ,  $-OPO_3H_2$  and  $\left[ O - \text{Si} - R^8 - \text{Si} \right]$ . Applicants note that the specification, at page 15, line 16, referring back to page 9, lines 16-22, fully defines the groups  $R^2$  and  $R^3$ . Applicants, therefore, assert that there remain no antecedent issues with respect to the amended claims, that the claims are in a condition for allowance, and respectfully request that the rejection be withdrawn.

Claims 10-11 are rejected under 35 U.S.C. 112, first paragraph, because allegedly the specification, while being enabling for the use of a hybrid inorganic-organic copolymer network having at least one backbone unit corresponding to  $[-O-Si(WX)-O-Si(YZ)-R1-O-R4-]$  (page 12, Structure H), does not reasonably provide enablement for a hybrid inorganic-organic copolymer network having at least one backbone unit corresponding to  $[-O-Si(WX)-O-Si(YZ)-R1-O-(R4)]$ .

The Examiner states that:

"The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention commensurate in scope with these claims. Notably, the former structure is **divalent** in nature; while the latter is **monovalent**. They are totally distinct from each other, and would impart different properties to the matrix as a whole, i.e., the divalent species will increase the crosslinking density, hardness, brittleness, etc. of the material. On the contrary, the monovalent species will create loose dangling ends; thus, impart the opposite characteristics to the material. One of ordinary skill in the art would not find them interchangeable, equivalent or obvious variants."

Claim 10 is herein amended merely to correct an obvious typographical error. The structure as now correctly given is  $[-O-Si(WX)-O-Si(YZ)-R1-O-R4-]$ , as shown in the Structure H, page 12, as noted by the Examiner. Applicants assert that the amendment to the claim 10 (and hence to claim 11 dependent therefrom) is fully supported by the specification. Applicants therefore respectfully request that this rejection be withdrawn.

Claim 40 was rejected under 35 U.S.C. 112, first paragraph.

This claim is herein canceled and this rejection is rendered moot.

## Rejection under 35 U.S.C. §102

Claims 2-9 were rejected 35 U.S.C. §102 as anticipated by Honma340 (US 2003/0003340). Applicants respectfully traverse this rejection.

The Examiner alleges that:

"Honma340 discloses a fuel cell comprising a flexible proton electrolyte membrane comprising a hybrid inorganic-organic copolymer network derived from a composition comprising components A), B) and C). Component A) can be tetraalkoxysilanes, etc. ([0099]) Component B) can be further described in [0100]-[0103], [0118], [0120]-[0125]. Component C) can be phosphoric acid or sulfonic acid. [0110] and [0126]-[0129]) ...."

Honma340 states:

[0126] Inorganic Acid (C)

[0127] The proton-conducting membrane of the present invention comprises an inorganic acid (C), in addition to the above-described three-dimensionally crosslinked siliconoxygen structure (A) and carbon-containing compound (B).

[0128] The inorganic acid for the present invention is responsible for increasing proton concentration in the proton-conducting membrane. Increased proton concentration is essential for realization of high proton conductivity for the present invention, in consideration of proton conductivity increasing in proportion to concentrations of proton and the proton-conducting medium (generally of water supplied separately).

[0129] The so-called protonic acid compound, which releases the proton, is used as the inorganic acid (C) as the agent for imparting proton conductivity. Types of the inorganic acid (C) as the agent for imparting proton conductivity include phosphoric, sulfuric, sulfonic, carboxylic, boric and heteropoly acid, and a derivative thereof. These acids may be used either individually or in combination for the present invention.

[0130] Of these, a heteropoly acid is more preferable for its resistance to heat and stability in the membrane, where heteropoly acid is a generic term for inorganic oxo acids, of which tungstophosphoric, molybdophosphoric and tungstosilicic acid of Keggin or Dawson structure are more preferable.

[0131] These heteropoly acids have sufficiently large molecular sizes to control elution of the acid out of the membrane to a considerable extent, even in the presence of water or the like. Moreover, they have ionic polarity and capacity of being bonded to hydrogen, **and are efficiently separated from the carbon-containing compound (B) phase to increase proton conductivity** [Emphasis added], as described earlier, and retained in the membrane by the polarity interactions with the silicon-oxygen bond to control elution of the acid out of the membrane. As such, they are especially suitable for the proton-conducting membrane which works at high temperature for extended periods.

[0132] The heteropoly acid may be supported beforehand by fine particles of metallic oxide, to be stably immobilized in the membrane. These metallic oxides include silica, alumina, titanium and zirconium. These fine particles are provided by various makers. For example, CHEMAT TECHNOLOGY, INC is supplying the fine particles of various metallic oxides dispersed in water, alcohol or the like, and Nippon Aerosil Co., LTD. is supplying fine particles of various types of silica.

[0133] Size of these fine particles of metallic oxide is not limited, but preferable size is normally in a range from 10 nm to 100pm. Those having a size below 10 nm are hard to obtain and limited in supporting effect. On the other hand, those having a size above 100 pm are too large for membrane thickness, and may work as the fracture origins in the membrane.

[0134] The heteropoly acid can be easily supported by the fine metallic oxide particles by mixing them in a solution. The solution containing the heteropoly acid and fine metallic oxide particles may be concentrated to produce the solids which are to be crushed. Moreover, the heteropoly acid supported by the fine metallic oxide particles may be used together with a free heteropoly acid not supported.

[0135] Of the inorganic solid acids, tungstophosphoric, molybdophosphoric and tungstosilicic acid are especially preferable in consideration of their high acidity, large size and magnitude of the polarity interactions with the metal-oxygen bond.

[0136] The heteropoly acid may be used together with another acid as described earlier, or with two or more other organic or inorganic acids for the inorganic acid (C).

Applicants note, for example, that in the present application Structures A1-G at page 11 illustrate direct covalent bonding of inorganic acid groups to the polymeric backbone of the membranes. Direct covalent bonding of the acid groups to the polymeric backbone structure is not taught by Honma340. Nowhere does cited reference Honma340 teach, or otherwise suggest, membranes that include an **inorganic acid bonded directly to the membrane**, as are claimed in claims 2-9 of the present application. Indeed, Honma340 teaches away from the claims of the present application. For example, Honma340 teaches (see [0131] above) that the inorganic acids (component C) may have the size to be elutable from the membrane, which would be not possible if the acids of Honma340 were bonded directly to the polymeric structure of the membrane, as taught and claimed by the present application.

Honma340, at paragraph [0134], further teaches that the inorganic acids (**i.e. component C**) may be supported by fine metallic or metallic oxide particles, again not possible if otherwise bonded to the membrane, and as is taught and claimed by the present application.

Applicants, therefore, assert that the cited reference Honma340, therefore, does not teach or suggest each and every element as claimed in claims 2-9 of the present application and respectfully request withdrawal of this rejection.

Claims 2-9 were rejected 35 U.S.C. §102 as anticipated by Honma138 (US Patent Serial No. 6,680,138). Applicants respectfully traverse this rejection.

The Examiner states:

Honma138 discloses a fuel cell comprising a flexible proton electrolyte membrane comprising a hybrid inorganic-organic copolymer network derived from a composition comprising components A), B), C) and D). (col. 4, lines 42-47) Component A) can be exemplified as bis(triethoxysilyl)butane, bis(hydrolysablesilyl) alkylene oxide, bis(hydrolysable-silyl)polyisobutylene, bis(hydrolysablesilyl) polyethylene, etc. (col. 5, line 22 to col. 6, line 53 and col. 7, line 14 to col. 8, line 2) Component B) can be exemplified in col. 8, lines 38-53 and col. 3, lines 7- 23. Since Honma138's composition reads on Applicants' composition described in the specification, the copolymer network contains the backbone units set forth in the instant claims. The proton conductivities of the membrane are illustrated in Examples. Notably, there is no humidifier or thermal management system used in Honma138's disclosure.

Applicants again assert, for the reasons presented above with respect to the Honma340 reference, that the cited reference Honma138 does not teach or suggest anywhere a fuel cell comprising a flexible proton electrolyte membrane, where the polymeric backbone of the membrane has inorganic acid groups bonded thereto, as is taught and claimed by the present application. Applicants note, in particular, the section in the cited reference Honma138 at column 9, lines 9-64, wherein component C (the inorganic acid) is taught, that there is no reference to a bonded acid. In addition, the reference states, Honma138 at column 9, lines 34-42, that the inorganic acid molecules are of sufficient size to control elution from the membrane, indicating that the acid molecules are free and not bound by covalent bonds to the membrane polymer.

Applicants, therefore, assert that the cited reference Honma138, therefore, does not teach or suggest each and every element of the invention as claimed in the present application and respectfully request withdrawal of this rejection.

#### **Rejection under 35 U.S.C. §103(a)**

Claim 12 was rejected under 35 U.S.C. §103 as purportedly being unpatentable over Honma138.

The Examiner stated:

Honma138 discloses a fuel cell comprising a flexible proton electrolyte membrane, supra, which is incorporated herein by reference. Honma138 is silent on the claimed network containing a short chain hydrocarbon spacer between two Si atoms and a long chain hydrocarbon spacer between another two Si atoms. However, Honma138 a bis(alkoxysilyl)-C4 to C20 alkane and a polyisobutylene or long chain PE end-capped with alkoxysilyl groups. (col. 6, lines 10-18 and col. 7, - lines 14-31) The polymer can have a MW of up to 1000

(col. 7, line 55 col 8, line 2). Since the bis(alkoxysilyl)-C4-C20 alkane and the hydrolysable silyl PIBPE for the same purpose (i.e., functioning as component A)) in the composition for preparing the hybrid inorganic-organic copolymer network, it would have been obvious to one of the ordinary skill in the art at the time the invention was made to utilize both of them as component A) with expected success. See MPEP 2144.06 (I)

Applicants respectfully traverse this rejection in the Office Action and submit that the rejection of claim 12 under 35 U.S.C. §103 in view of Honma138 should be withdrawn because, as asserted above, the cited reference Honma138, does not teach, disclose, or otherwise suggest the membranes as taught and claimed in claim 12 of the present application.

### **CONCLUSION**

In light of the foregoing amendments and for at least the reasons set forth above, Applicants respectfully submit that all objections and/or rejections have been traversed, rendered moot, and/or accommodated. Favorable reconsideration and allowance of the present application and all pending claims are hereby courteously requested.

In addition, any other statements in the Office Action that are not explicitly addressed herein are not intended to be admitted. In addition, any and all findings of inherency are traversed as not having been shown to be necessarily present. Furthermore, any and all findings of well-known art and official notice, or statements interpreted similarly, should not be considered well known since the Office Action does not include specific factual findings predicated on sound technical and scientific reasoning to support such conclusions.

If, in the opinion of the Examiner, a telephonic conference would expedite the examination of this matter, the Examiner is invited to call the undersigned attorney at (770) 933-9500.

Respectfully submitted,

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